

#### 4.—WEST AUSTRALIAN FRESHWATER CALANOIDS (COPEPODA).

##### II.—TWO NEW SPECIES OF *BRUNELLA*, WITH AN ACCOUNT OF THE DEVELOPMENTAL STAGES OF *B. SUBATTENUATA* n. sp.

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##### INTRODUCTION.

Smith (1909, p. 87) proposed the genus *Brunella* for a freshwater Copepod from Tasmania and gave a list of generic features. The species described in the present paper bring the total number of species of *Brunella* so far discovered to nine, all of them freshwater and found in New Zealand, Tasmania, Victoria, and now the South-West of Australia; in addition, Dr. A. G. Nicholls has kindly shown me an unpublished description of a new species of *Brunella* taken in a salt lake in South Australia. In the light of this material, some modification of Smith's original definition of the genus seems desirable. The following definition is therefore proposed:—

Centropagidae with the segmentation of the endopods of the swimming legs reduced, the first being unsegmented, the second, third, and fourth two-segmented; the fifth exopods in the female are typical for the family; in the male the terminal segment of the left fifth exopod is comparatively short and flattened, that on the right is elongated to form part of a long hook; the head is separate from the thorax which is fully segmented, and whose posterior corners may be rounded or produced into acute processes; the female abdomen is three-segmented and bears a very prominent ventral bulge on the genital segment.

##### DESCRIPTION OF NEW SPECIES.

###### Order CALANOIDA.

###### Family CENTROPAGIDAE Sars, 1902.

###### Genus *BRUNELLA* Smith, 1909.

###### *Brunella attenuata* n. sp.

##### LOCALITIES.

1. An artificial concrete pond in the University Quad. (Winter).
2. A perennial natural pond, thickly overgrown with weeds, in the University grounds (Winter).
3. A reedy swamp one to two acres in extent and two to three feet deep, surrounded by paperbark trees, 20 miles along the road between Albany and the Porongorups; probably dry in Summer (Spring).

In all these localities it was found in association with *B. subattenuata* n. sp.

## COLOUR.

The extent and intensity of colour is very variable within a local colony, and those specimens from locality 3 were much darker than ones from clearer water. Eyespot red, thoracic rings and bases of legs blue, mouthparts and genital swelling reddish-brown, rest of the body hyaline. Ova greenish-blue and red.

## FEMALE.

Size : 1.48 to 1.65 mm.

Head, which has a nuchal groove, distinct from the five thoracic segments, the last of which has rounded posterior corners and two patches of minute spinules on either side, one postero-dorsal, the other postero-lateral. Rostrum very short, bifid, and hyaline. Thorax 2.5 times as long as wide. Abdomen three-segmented, the genital swelling being very large and smoothly rounded. Caudal rami somewhat longer than the anal segment and little more than three times as long as wide (as measured at their base).

Mouthparts : First antenna, 25-segmented, extending beyond the caudal rami by one to five segments. Rami of second antenna subequal in length. Mandibular blade large in comparison with palp, and the exopod small (though neither of these features is so marked as in *B. subattenuata* n. sp.). The other mouthparts agree with those of *B. subattenuata* (Plate II.).

Swimming Legs : Seta formula of first four pairs of legs is as follows :—

				endopod	exopod
p. 1	...	...	...	421	1.1.322.0.1
p. 2	...	...	...	3.422	1.1.421.1.1
p. 3	...	...	...	3.422	1.1.421.1.1
p. 4	...	...	...	3.322	1.1.421.1.1

Fifth leg typical for genus, but in some specimens there was a faint line of segmentation in the proximal endopod segment, making a total of three segments (Plate I., Fig. 7).

Single ovisac containing five to nine eggs.

## MALE.

Size : 1.16 to 1.28 mm.

Head and thorax as in the female, the head with a nuchal groove, but the posterior thoracic segment bears only the postero-dorsal patch of spinules. Rostrum longer than in female and curved. Head and thorax 2.8 times as long as wide, and the ratio of abdomen to head and thorax is 1.0 : 2.2 ; abdomen five-segmented. Caudal rami longer than anal segment and rather over two and a half times as long as wide.

Right first antenna geniculate, of 22 segments, bearing one spine on segments 8, 10, 11, 17, and 18, and two on segment 19 ; left antenna 25-segmented.

Fifth legs (Plate I., Figs. 8 and 9) have an unsegmented left exopod and endopod two-segmented ; the exopod appears to be distally expanded and flattened, one apical corner being turned over as a flap and the other corner serrate ; apically this lamella bears a slender spine. Second basal segment of left leg projects as a more or less bifid process forming a cup in which is inserted the endopod. Right leg typical for the genus, second exopod segment reaching to the base of the caudal rami.



***Brunella subattenuata* n. sp.**

## LOCALITIES.

1, 2, and 3 as in the preceding species.

4. A number of ponds in the laterite by the road between Albany and the Porongorups, which would by dry in Summer (Spring).

5. Albany—a pond of discoloured water the colour of tea, and a muddy swamp overgrown with reeds (Spring).

## COLOUR.

Very much like the preceding species and equally variable (the hue of an individual was found to change over a period of a few days). Swimming legs sometimes pink : ova dark green.

## FEMALE.

Size : 0.92 to 1.28 mm.

Body very much like the preceding species, nuchal groove being present, but spinules on the last thoracic segment wanting. Rostrum small, curved, and bifid. Swelling on genital segment very large and usually somewhat angular. Ratio of abdomen to head and thorax, 1.0 : 1.7. Caudal rami nearly five times as long as wide (as measured at the base).

Mouthparts (Plate II.) : First antenna 25-segmented and extending beyond the caudal rami by three or four segments. Second antenna typical, rami subequal and terminal endopod segment bearing eight lateral and eight terminal setae. Mandible blade very large ; exopod small ; endopod has four setae on first segment and eight on the second ; basis bears three setae. First maxilla consists of the usual lobes ; epipod with nine setae, exopod with seven, endopod showing only a trace of segmentation with 1 + 2 + 5 setae, the first inner lobe with two and the second with four stout setae. Second maxilla has five lobes, each with three setae ; sixth lobe with a single seta, and terminal portion bears four setae. Maxilliped of seven segments ; the first bears four protuberances, the distal of which is greatly developed, and these bear one, two, three, and four setae ; second segment bears three setae ; third has three setae and a papilla bearing two setae ; fourth, fifth, and sixth segments bear three, two, and one setae respectively, the sixth bearing an additional seta on the posterior margin ; terminal segment bears four setae.

Seta formula for swimming legs agrees with that for *B. attenuata* n. sp. Fifth legs typical and endopod always two-segmented.

A single ovisac with usually eight to eleven eggs.

## MALE.

Size : 0.90 to 1.00 mm.

Head and thorax as in female ; caudal rami nearly three times as long as wide. Ratio of abdomen to head and thorax, 1.0 : 2.2.

First antennae very much like those of *B. attenuata* ; the right 22-segmented with a spine on segments 8, 10, and 11, and two on segment 19 ; the left 25-segmented.

Fifth legs resemble those of *B. longicornis* Searle (Plate III., Figs. 9–11). Both rami of left leg two-segmented ; terminal endopod segment with six setae like the right, and terminal exopod segment flattened with one large conical spine and one smaller one ; second basal segment produced at its

corner to form a cup for the insertion of endopod, this projection reaching almost to the end of first exopod segment, and rendering the insertion of endopod considerably distal to that of exopod. Right limb of the usual form.

This species resembles *B. longicornis* Searle (1912), but from Searle's description appears to be distinct in a number of points in the male fifth leg, and also in the length of the female caudal rami.

*Note on the Specimens from Albany.*

These varied from specimens from other localities in the following points :—

1. The majority of females measured 1.37 to 1.46 mm., with only a few as small as 1.2 mm. ; the males were 1.0 mm.
2. The females carried about 50 ova in their ovisacs.
3. The first antennae extended beyond the furcae by only two segments.
4. The female genital segment bore a bulge on the right side at the anterior end (Plate III., Fig. 3).
5. The first exopod segment of the left male fifth leg was broader, nearly as broad as the second exopod segment.

THE DEVELOPMENTAL STAGES OF *BRUNELLA SUBATTENUATA*  
n. sp.

*Method :* The adult Copepods bred freely in a large open porcelain dish in which the water was kept about one inch deep ; from here they could be caught and transferred to petrie dishes and watchglasses, in which filtered pondwater was used. It was found impossible to catch the nauplii individually in even these small vessels, so a number of egg-bearing females were permitted to breed for some time in one vessel, formalin was then added and the nauplii picked out with the aid of a microscope. By this means no stage I. nauplii were found ; to obtain the first stage, 10 egg-bearing females were placed in separate watch-glasses and examined daily with the binocular microscope. Although these eggs were kept for over a month, and their parents were in some cases still alive after this time, none of them hatched. After a fortnight a number of eggs from each batch became clear, the others remaining black and opaque ; within these clear ova there appeared a distinct eyespot, and towards the posterior end blue and red oil globules ; there was never any movement, though some were kept in this condition for three weeks. No description of the first nauplius was therefore possible. This species was found in a number of localities (p. 69) liable to be dry in Summer, and since the breeding work was carried out during October and November it is possible that these were resting-eggs ; in this event, those which became clear were probably fully-developed nauplii in the first stage, as Borutzky (1929) has described for *Canthocamptus arcticus* which in this stage survives cold and dry periods (most of the year) within a thick resting-egg. In two cases female copepods thus isolated in watch-glasses produced two batches of eggs. In all the watch-glasses the egg sac was dropped by the female after a week or a fortnight.

COPULATION.

Copulation was observed in this species. A pair was seen to be swimming round with the male behind and grasping the female abdomen in its geniculate antenna. After a minute or two they settled down. The male flicked its ab-



domen forward two or three times and finally succeeded in swinging it completely forward, and was then seen to be clasping the female abdomen by means of its fifth legs and by twisting its own relatively flexible abdomen partially around that of the female.

Both the species of *Brunella* described in this paper, in contrast to species of *Boeckella* previously worked with, jump about very actively when their water is in the least disturbed.

The ova are greenish black, subspherical, and 0.098 mm. in diameter.

#### THE NAUPLII.

Apart from stage I., the general form of the nauplii is very much like that of *Boeckella opaqua* Fairbridge (1944), which seems in turn to be fairly typical for the Centropagidae. They are colourless and the eyespot is red with a patch of blue in front of it : stage II. is an exception, in that the posterior region of the body is a purplish colour due to red and blue pigmentation, and there is no gut visible owing to the body being rendered opaque by the presence of oil globules. All measurements exclude the caudal spines and setae.

#### *Nauplius II.*

Body : 0.148 and 0.156 mm. (Plate IV., Figs. 1 and 2).

Rather squat in side view with labrum tucked under ; caudal region bears two subequal setae. Labrum smooth ; distinct rostral prominence.

First antenna (Plate IV., Fig. 7) : Three-segmented ; the first with one, the second with two, and the third with two apical and one subapical setae ; third segment bears also some hairs on the dorsal margin.

Second antenna (Plate V., Fig. 1) : Coxa with one seta and a strong masticatory hook ; basis with three setae, the proximal of which is strong and plumose ; endopod with two setae laterally and three apically ; exopod of five segments, the first and last bearing two setae, and the others one each.

Mandible (Plate V., Fig. 6) : Coxa produced somewhat on the inner margin, but not toothed, with a strong plumose seta ; basis with two such setae ; endopod with a total of eight setae, the three proximal ones strong and plumose ; exopod of four segments, each with one seta save the fourth, which has two.

#### *Nauplius III.*

Body : Length 0.164 mm. (average of 11 specimens).

After stage II. the body becomes gradually more elongate, and the labrum projects more ; the caudal region is cleft forming two lobes, the left of which is slightly the larger throughout the subsequent nauplii ; these caudal lobes bear each a stout spine and a slender seta, the right seta being carried usually reflexed forwards along the back ; the labrum is smooth in stage III.

First antenna (Plate IV., Fig. 8) : First two segments as in stage II. Third segment bears three setae apically, two only of which are stout and plumose ; ventral margin with one seta, and dorsal with two, one of which is plumose and almost as big as the two strong apical setae.

Second antenna (Plate V., Fig. 2) : Coxa with two masticatory hooks and one seta ; basis with one masticatory hook and three setae ; endopod with three setae laterally and four apical ; exopod as in stage II., but terminal segment with three setae.

Mandible (Plate V., Fig. 7): Coxa with one stout plumose seta; basis with three such setae and one normal one; endopod and exopod as in stage II., though the plumose setae appear somewhat stronger.

First maxilla: Present as a distinct lobe.

*Nauplius IV.*

Body: Length 0.195 mm. (average of eight specimens).

Labrum hairy at tip. The general form agrees with that of stage V. (Plate IV., Figs. 3 and 4).

First antenna (Plate IV., Fig. 9): As in stage III., but third segment with three setae on ventral margin and four on dorsal, the third and fourth of which are strong and plumose.

Second antenna (Plate V., Fig. 3): As in stage III., but basis with one masticatory hook and four setae.

Mandible (Plate V., Fig. 8): Coxa produced into a toothed chewing process bearing one stout plumose seta; basis bears four such setae and one normal seta; endopod produced inwards somewhat at the base and carries a total of ten setae, four of which are apical, and the three proximal ones are stout and plumose; proximal segment of exopod bears a small additional seta.

First maxilla: A notched lobe bearing five pairs of setae.

*Nauplius V.*

Body: Length 0.218 mm. (average of five specimens).

Labrum hairy at tip. The general form of the nauplius is shown in Plate IV., Figs. 3 and 4.

First antenna (Plate IV., Fig. 10): As in stage IV., but with four setae on ventral margin and six on dorsal, the distal two of which are plumose.

Second antenna (Plate V., Fig. 4): As in stage IV., but endopod with four setae laterally and five apical; exopod of seven segments, the proximal unarmed, the second with two setae, and the apical with three.

Mandible (Plate V., Fig. 9): As in stage IV.

First maxilla (Plate V., Fig. 11): Shows an indication of three lobes, exopod bearing three setae, endopod five, and the other lobe two.

*Nauplius VI.*

Body: Length 0.253 mm. (average of 11 specimens).

There is an additional spine on each caudal ramus interior to the seta; the general form is shown in Plate IV., Figs. 5 and 6. Labrum hairy at tip.

First antenna (Plate IV., Fig. 11): As in stage V., but terminal segment bears five setae on ventral margin and eight on dorsal margin.

Second antenna (Plate V., Fig. 5): As in stage V., but second exopod segment bears an additional seta.

Mandible (Plate V., Fig. 10): As in stage V.

First maxilla (Plate V., Fig. 12): Gnathobase and epipod developed as lobes bearing two minute and one normal seta respectively; exopod bears three setae, endopod six and the inner lobe two.

Second maxilla: A three-segmented appendage with about fifteen setae on the inner margin, but with only the barest indication of lobes.



Maxilliped : Present as a lobe with two terminal setae, and partial segmentation into three.

First and Second swimming legs : Rudimentary.

TABLE I.—The Naupliar Appendages.

First antenna.

Stage.						1st Segment.	2nd Segment.	3rd Segment.
II.	...	...	...	...	...	S	2S	3p
III.	...	...	...	...	...	S	2S	3p 3S
IV.	...	...	...	...	...	S	2S	4p 6S
V.	...	...	...	...	...	S	2S	4p 9S
VI.	...	...	...	...	...	S	2S	4p 12S

Second antenna.

Stage.						Coxa.	Basis.	Endopod.	Exopod.
II.	...	...	...	...	...	MS	F2S	2S 3Sp	2p.p.p.p.2p
III.	...	...	...	...	...	2MS	M3S	3S 3Sp	2p.p.p.p.3p
IV.	...	...	...	...	...	2MS	M4S	3S 3Sp	2p.p.p.p.3p
V.	...	...	...	...	...	2MS	M4S	4S 4Sp	0.2p.p.p.p.p.3p
VI.	...	...	...	...	...	2MS	M4S	4S 4Sp	0.3p.p.p.p.p.3p

Mandible.

Stage.						Coxa.	Basis.	Endopod.	Exopod.
II.	...	...	...	...	...	F	2F	3F 5S	S.S.S.2S
III.	...	...	...	...	...	F	3FS	3F 5S	S.S.S.2S
IV.	...	...	...	...	...	BF	4FS	3F 7S	2S.S.S.2S
V.	...	...	...	...	...	BF	4FS	3F 7S	2S.S.S.2S
VI.	...	...	...	...	...	BF	4FS	3F 7S	2S.S.S.2S

S = Seta.

p = Plumose seta.

F = Plumose seta modified for feeding.

M = Masticatory hook.

B = Toothed mandibular blade.

THE COPEPODIDS.

The copepodid stages are quite typical : the second antenna, mandible, and first and second maxilla bearing all the main adult features in the first stage, and in later stages showing an increase only in the number of setae, the second antenna and mandible altering in the endopods only. The first antenna and maxilliped on the other hand show an increase in segmentation as well as in armature up to the adult condition.

The setation and segmentation of the swimming legs is shown in tabular form on p. 76. Table II.

All measurements were made to the end of the caudal rami.

*Copepodid I.*

Size : 0.38 mm. (average of two specimens).

Thorax five-segmented ; abdomen (Plate VI., Fig. 1) one-segmented : the caudal setae not fully developed, inner seta wanting and two of the apical setae strong, while two but weakly developed.

Mouthparts : First antenna 11-segmented, segments three and four long and showing indications of subdivision. Second antenna (Plate VI., Fig. 2) much less slender than in adult, especially in endopod ; setation of coxa, basis, and exopod agrees with that of adult, while first endopod segment bears a pair of setae, and terminal segment a tuft of three setae laterally and five apically. Blade of mandible (Plate VI., Fig. 3) as in adult, large ; basis bears three setae but is less slender than in later stages ; exopod agrees with adult save for its relatively larger size ; first endopod segment bears three, and terminal five setae. All lobes of first maxilla (Plate VI., Fig. 4) present ; epipod bears four long plumose setae ; exopod three setae ; endopod shows only a trace of segmentation with one seta laterally and four apically ; first and second inner lobes bear four and two setae as in adult ; gnathobase has considerably less teeth than in adult. Second maxilla (Plate VI., Fig. 5) already nearly in adult condition, though segmentation is indistinct and the lobes each bear two setae only. Maxilliped (Plate VI., Fig. 6) four-segmented ; the first showing four protuberances bearing one, one, one and two setae ; second segment bears two setae, the third one, and the fourth four.

Swimming Legs : First two pairs present and third pair indicated by lobes. Both rami of first two pairs of legs unsegmented.

*Copepodid II.*

Size : 0.46 mm. (average of three specimens).

Abdomen incompletely two-segmented and caudal setae in the adult condition.

Mouthparts : First antenna (Plate VI., Fig. 7) is of a possible 17 segments, though four of these divisions are indistinct. Second antenna more elongate than in stage I. (this process of elongation proceeding throughout the copepodids), and terminal endopod segment bears four setae laterally and six apically. Mandible as in stage I. Epipod of first maxilla bears six setae, and the other lobes agree with stage I., and there are more teeth on gnathobase. Basal lobe of second maxilla now bears three setae, but the other lobes only two each. Maxilliped (Plate VI., Fig. 8) five-segmented ; anterior distal corner of basal segment taking on the adult form ; first segment bears one, two, two and three setae on its protuberances, second segment two setae ; the third bears one seta and a proximal papilla with two setae ; the fourth has one seta and the fifth four.

Swimming Legs : Three pairs are present, and the fourth present as buds. Exopods of the first two pairs and endopods of the second pair, two-segmented ; the first endopods and both rami of the third pair are unsegmented.

*Copepodid III.*

Size : 0.56 mm. (average of five specimens).

The abdomen is two-segmented.

Mouthparts : First antenna 23-segmented. Second antenna agrees with the adult, save that the terminal endopod segment bears five setae laterally and six apically. Mandible agrees with that of stage II. Epipod of first



maxilla bears eight setae, exopod four; endopod now three-segmented, the segments bearing one, two, and four setae. Second maxilla agrees with stage II. Maxilliped (Plate VI., Fig. 9), is of six segments; the first with one, two, two, and four setae, second segment with two, the third with one seta and two on a papilla, the fourth one, the fifth with one seta on both the anterior and posterior margins, and the sixth with four.

Swimming Legs: Four pairs are present, the fifth are indicated as buds. First endopod unsegmented, exopod three-segmented; second endopod two-segmented, exopod three; both rami of the third pair are two-segmented, and both rami of the fourth pair unsegmented.

#### *Copepodid IV.*

Size: Male, 0.64 mm. (one specimen); female, 0.64 mm. (average of five specimens).

Abdomen in female three-segmented, the division between the first and second segments being indistinct. Male abdomen indistinctly four-segmented, the last being the longest.

Mouthparts: First antennae in both sexes 24-segmented. Second antenna agrees with the adult save that terminal endopod segment bears six setae laterally and six apically. Mandible agrees with the adult save that first endopod segment bears four setae and the apical segment six. First maxilla agrees with stage III., save that exopod bears six setae, and the apical endopod segment five. Second maxilla agrees with the adult. Maxilliped is of six segments, differing from the adult in bearing only two setae on segments three and four, one anterior and one posterior on the fifth, and four setae on the sixth.

Swimming Legs: Five pairs are present, and the segmentation of the first four does not differ from that in the adult. Female fifth legs (Plate VI., Fig. 10) very similar to those of male (Plate VI., Fig. 11) but may be distinguished by the exopod bearing three setae apically instead of two setae and two spines as in the male. Segmentation of exopod is indistinct in the case of the female.

#### *Copepodid V.*

Size: Male, 0.74 mm. (average of seven specimens); female, 0.96 mm. (average of six specimens).

Abdomen of the female (Plate VI., Fig. 12) with a ventral protuberance on the genital segment; male abdomen four-segmented, the last segment being as long as the caudal rami.

Mouthparts: First antennae 25-segmented in both sexes and show no sign of asymmetry or spines. Second antennae are like those of the adult save that terminal endopod segment bears seven setae laterally and seven apically. Mandible agrees with that of stage IV. First and second maxillae agree with the adult, as does also the maxilliped.

Swimming Legs: The segmentation of the first four pairs agrees with the adult. Fifth legs of the female (Plate VI., Fig. 13) show only a slight trace of segmentation in the endopods; inner marginal spine of second exopod segment not fully formed, and terminal exopod segment bears four inner marginal spines and a stouter apical spine as in the adult (in one specimen these inner spines were three in number and reduced in size). In the male (Plate VI., Fig. 14) the fifth endopods show traces of segmentation.

TABLE II.—Armature and Segmentation of Swimming Legs.

*1st Leg.*

Stage.	Coxa.	Basis.	Endopod.		Exopod.	
			Segmentation.	Armature.	Segmentation.	Armature.
I. ...	...	...	1	p2p	1	pppSss
II. ...	...	...	1	ppp2p	2	o.ppppSs.o
III. ...	...	p	1	ppp2pp	3	p.p.ppppSs.o.o
IV. ...	...	p	1	pppp2pp	3	p.p.ppppSs.o.o
V. ...	...	p	1	pppp2pp	3	p.p.ppppSs.o.o
Adult ...	...	p	1	pppp2pp	3	p.p.ppppSs.o.o

*2nd Leg.*

Stage.	Coxa.	Basis.	Endopod.		Exopod.	
			Segmentation.	Armature.	Segmentation.	Armature.
I. ...	...	...	1	pp2p	1	ppSs
II. ...	...	p	2	o.pp2pp.o	2	o.ppppSs.s
III. ...	...	p	2	o.pp2pp.o	3	o.p.ppppSs.s.s
IV. ...	...	p	2	pp.ppp2pp.o	3	p.p.ppppSs.s.s
V. ...	...	p	2	ppp.pppp2pp.o	3	p.p.ppppSs.s.s
Adult ...	...	p	2	ppp.pppp2pp.o	3	p.p.ppppSs.s.s

*3rd Leg.*

Stage.	Coxa.	Basis.	Endopod.		Exopod.	
			Segmentation.	Armature.	Segmentation.	Armature.
II. ...	...	...	1	pp2pp	1	pppSs
III. ...	...	p	2	p.ppp2pp.o	2	o.ppppSs.s
IV. ...	...	p	2	pp.ppp2pp.o	3	p.p.ppppSs.s.s
V. ...	...	p	2	ppp.pppp2pp.o	3	p.p.ppppSs.s.s
Adult ...	...	p	2	ppp.pppp2pp.o	3	p.p.ppppSs.s.s

*4th Leg.*

Stage.	Coxa.	Basis.	Endopod.		Exopod.	
			Segmentation.	Armature.	Segmentation.	Armature.
III. ...	...	...	1	pp2p	1	pppSs
IV. ...	...	p	2	pp.pp2pp.o	3	o.p.ppppSs.s.s
V. ...	...	p	2	ppp.ppp2pp.o	3	p.p.ppppSs.s.s
Adult ...	...	p	2	ppp.ppp2pp.o	3	p.p.ppppSs.s.s

p = Seta.  
 2p = The two apical endopod setae.

s = Outer-edge spine.  
 S = Apical spine.



## DISCUSSION.

The five nauplius stages described are strikingly similar to those of *Boeckella opaqua* Fairbridge (1944), not only in their general shape, but in the shape and setation of their appendages, even the first antennae agreeing in the number of setae for stages II. to V. and differing in stage VI. only to the extent of one seta. The first antennae do differ, however, in that the three pronounced apical plumose setae of *Boeckella* are represented in the present species by two strong apical plumose setae, and one very much weaker non-plumose seta ; as if to compensate for this reduction of terminal setae, the dorsal subterminal seta is plumose and very stout, and the same applies to a lesser extent to the dorsal one adjacent to it in later stages. The armature of the caudal rami is of the same type in the two species, differing only in the relative stoutness of the spines.

This very strong similarity of the last five nauplius stages of *Brunella* with those of *Boeckella* make it reasonable to suppose that the first nauplius of *Brunella*, when found, will also prove to be like that of *Boeckella*. Lacking any evidence to the contrary, we can in the meantime say that a comparison of the larvae of these two genera demonstrates a very close relationship between them.

In respect of the copepodids, Johnson (1934, p. 480) found that in *Epi-labidocera amphitrites* and also in *Tortanus discaudatus* (Johnson, 1934a), each leg has unsegmented rami at its first appearance, and at the first moult the exopod becomes two-segmented and remains so till stage V., in which it is three-segmented, and the endopods for the first time two-segmented ; in *Centropages* and *Calanus finmarchicus*, however, the endopods being three-segmented in the adult, become two-segmented at the time of the exopods (*i.e.*, at the first moult), and both rami then acquire the adult segmentation in stage V. *Boeckella* follows this latter type, having all its swimming legs fully segmented. But *Brunella*, since the segmentation of the endopods in the adult tends to be suppressed, maintains the juvenile unsegmented first endopod throughout, and the other endopods become two-segmented in their first moult and remain so for the subsequent stages, while the exopods acquire a segment at each of the first two moults, thus attaining the adult condition earlier than in the two types mentioned above (the fourth exopod is an exception in becoming three-segmented at the first moult).

The development of the male fifth legs is quite straightforward ; but they are markedly different in stage V. from those of the female, thus resembling *Boeckella* and differing from *Centropages hamatus* (Gurney, 1931, p. 89 and Fig. 103) in beginning already to take on their highly modified form.

## CONCLUSION.

The freshwater Calanoid fauna of the South-West of this State is recruited from two genera, *Boeckella* and *Brunella*, which seem to have arisen from a common stock. They are both genera in which variability seems to centre in the thoracic wings of the females and in the fifth legs of the males and in little else, the two genera being much alike in nearly all their characters. *Brunella* has developed along the path of reduction of the segmentation of the endopods of the swimming legs and modification of the male left fifth exopod, whereas *Boeckella* exhibits a progressive reduction in the fifth endopods. *Brunella* is confined within an area inside the geographical range of *Boeckella*, and has been found in New Zealand, Tasmania, Victoria, South Australia (*see* p.67), and South-West Australia. The genus seems, therefore, to have spread freely along the lines of latitude, but not in a North-South direction ;

the usual explanation for such a distribution is given as that of climate. Incidentally this distribution (this is the first record of *Brunella* from this coast of Australia) is one further link between the fauna of the South-Western coastal area and that of the South-East and Tasmania—regions which have been shown (Nicholls, 1933) to have closer faunistic relations with one another than with the intervening regions.

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#### PLATE I.—*Brunella attenuata* n. sp.

- Fig. 1. Female, lateral.
- Fig. 2. Female abdomen, dorsal.
- Figs. 3 and 4. Male abdomen, dorsal and lateral.
- Fig. 5. Male, right first antenna.
- Fig. 6. First swimming leg.
- Fig. 7. Female, fifth leg.
- Fig. 8. Male left fifth leg, seen from the interior margin.
- Fig. 9. Male fifth pair of legs.



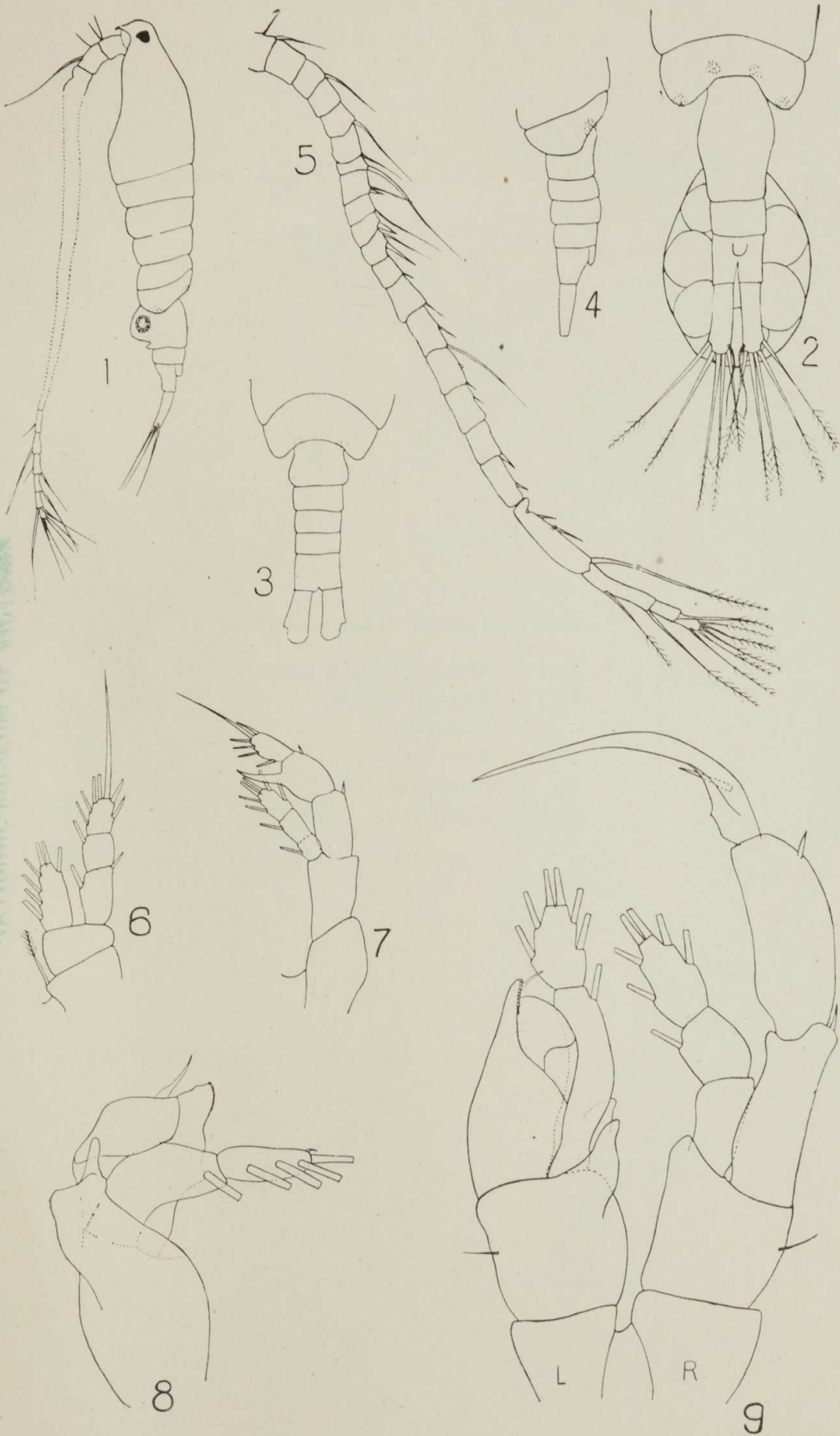


PLATE I.

PLATE II.—*Brunella subattenuata* n. sp.

- Fig. 1. Male, right first antenna.
- Fig. 2. Second antenna.
- Fig. 3. Mandible.
- Fig. 4. First maxilla.
- Fig. 5. Second maxilla.
- Fig. 6. Maxilliped.



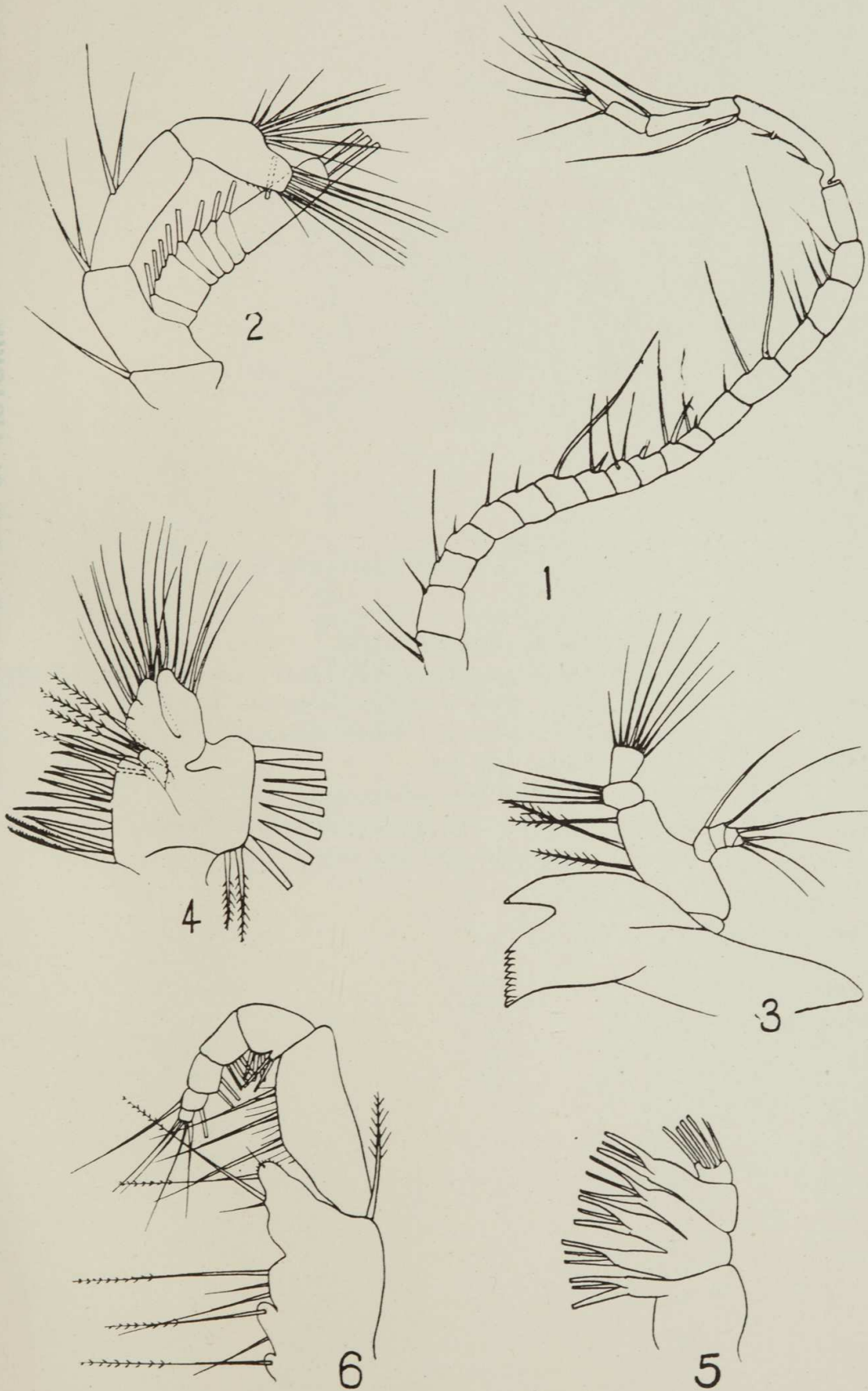


PLATE II.

PLATE III.—*Brunella subattenuata* n. sp.

- Fig. 1. Female, lateral.
- Fig. 2. Female abdomen, dorsal.
- Fig. 3. Female genital segment, dorsal ; specimen from Albany.
- Figs. 4 and 5. Male abdomen, dorsal and lateral.
- Figs. 6 and 7. First and fourth swimming legs.
- Fig. 8. Female fifth leg.
- Fig. 9. Male fifth legs, posterior aspect.
- Fig. 10. Male left fifth leg, from the outer margin.
- Fig. 11. Male right fifth leg, anterior aspect.



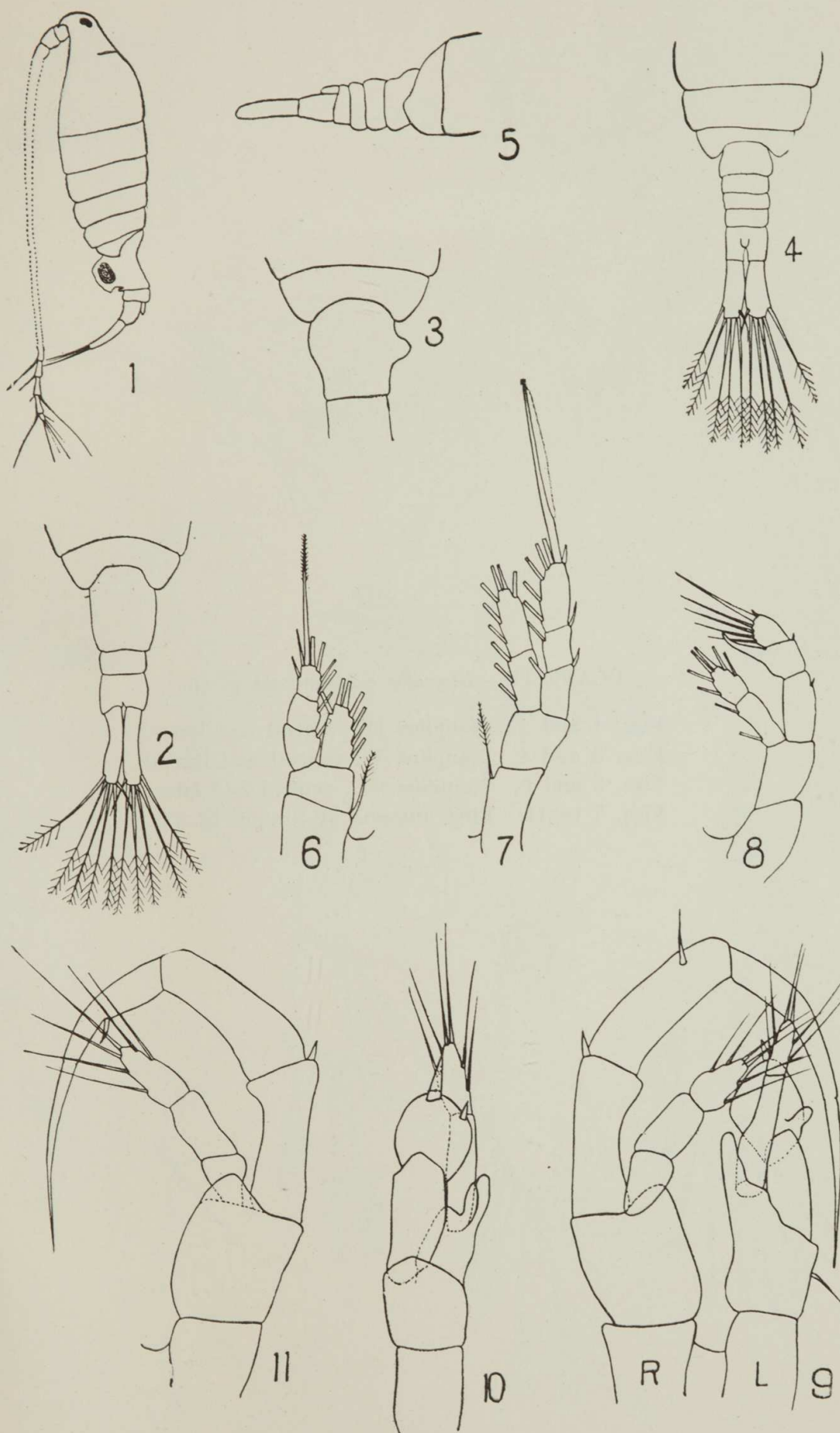


PLATE III.

PLATE IV.—*Brunella subattenuata* n. sp.

- Figs. 1 and 2. Nauplius II., ventral and lateral.  
Figs. 3 and 4. Nauplius V., ventral and lateral.  
Figs. 5 and 6. Nauplius VI., ventral and lateral.  
Figs. 7 to 11. First antenna of Nauplii II.-VI.



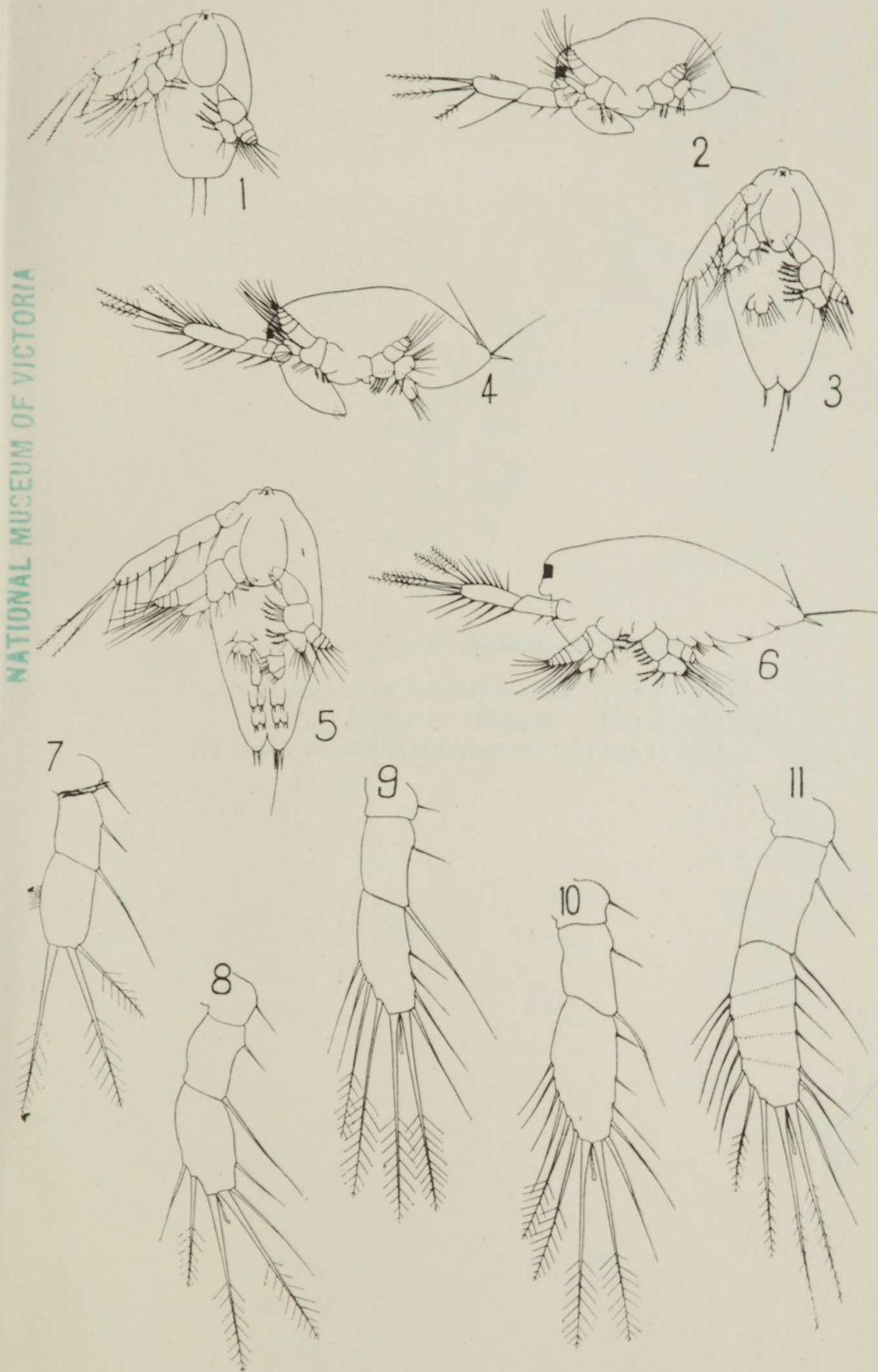


PLATE IV.

PLATE V.—*Brunella subattenuata* n. sp.

Figs. 1 to 5. Second antenna of Nauplii II.-VI.

Figs. 6 to 10. Mandible of Nauplii II.-VI.

Figs. 11 and 12. First maxilla of Nauplii V. and VI.



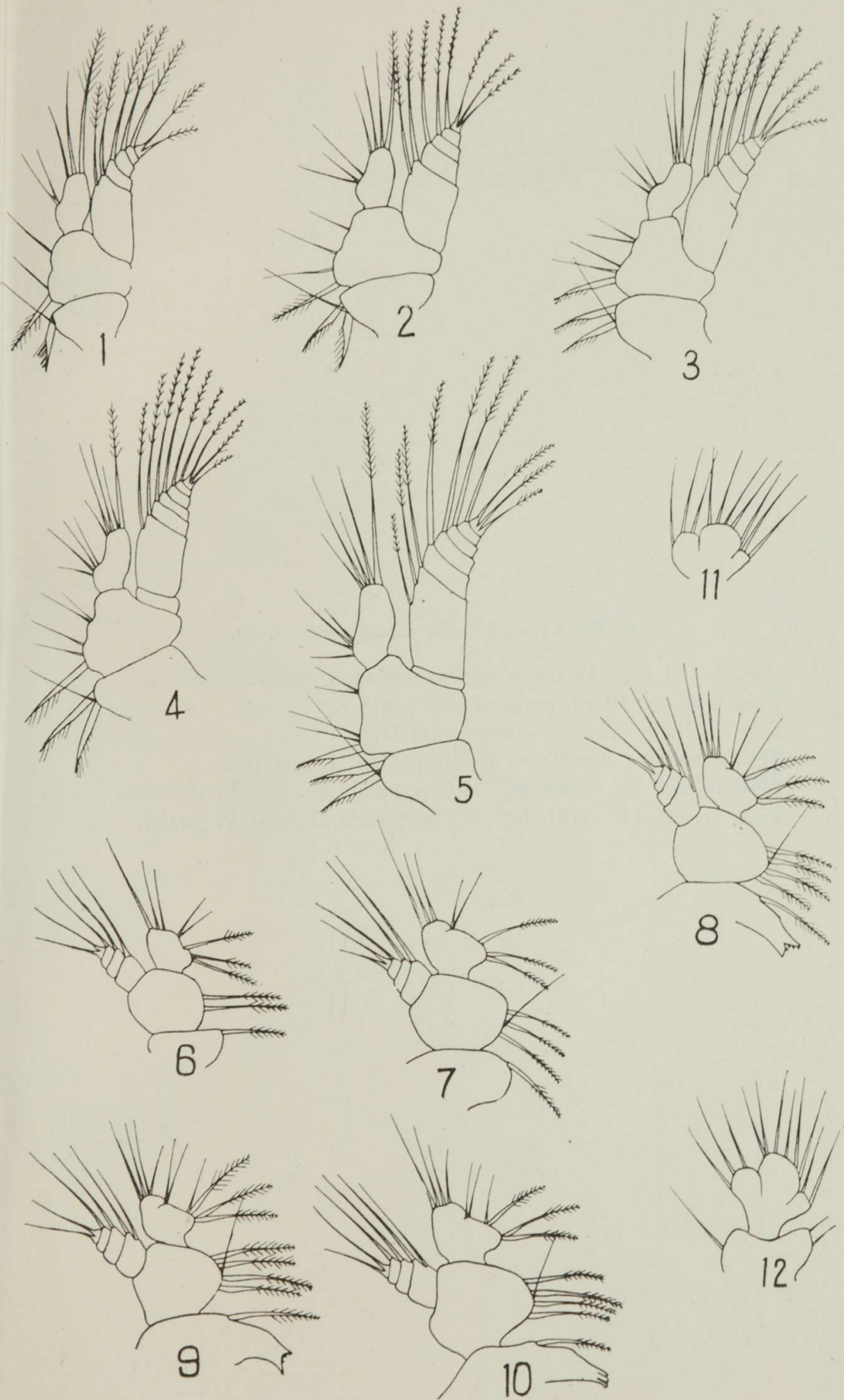


PLATE V.

PLATE VI.—*Brunella subattenuata* n. sp.

- Figs. 1 and 12. Abdomen of Copepodids I. and V. (female).  
Figs. 2 to 6. Mouth parts of Copepodid I.  
Fig. 7. First antenna of Copepodid II.  
Figs. 8 and 9. Maxilliped of Copepodids II. and III.  
Figs. 10 and 13. Fifth legs of Copepodids IV. and V. (female).  
Figs. 11 and 14. Fifth legs of Copepodids IV. and V. (male).



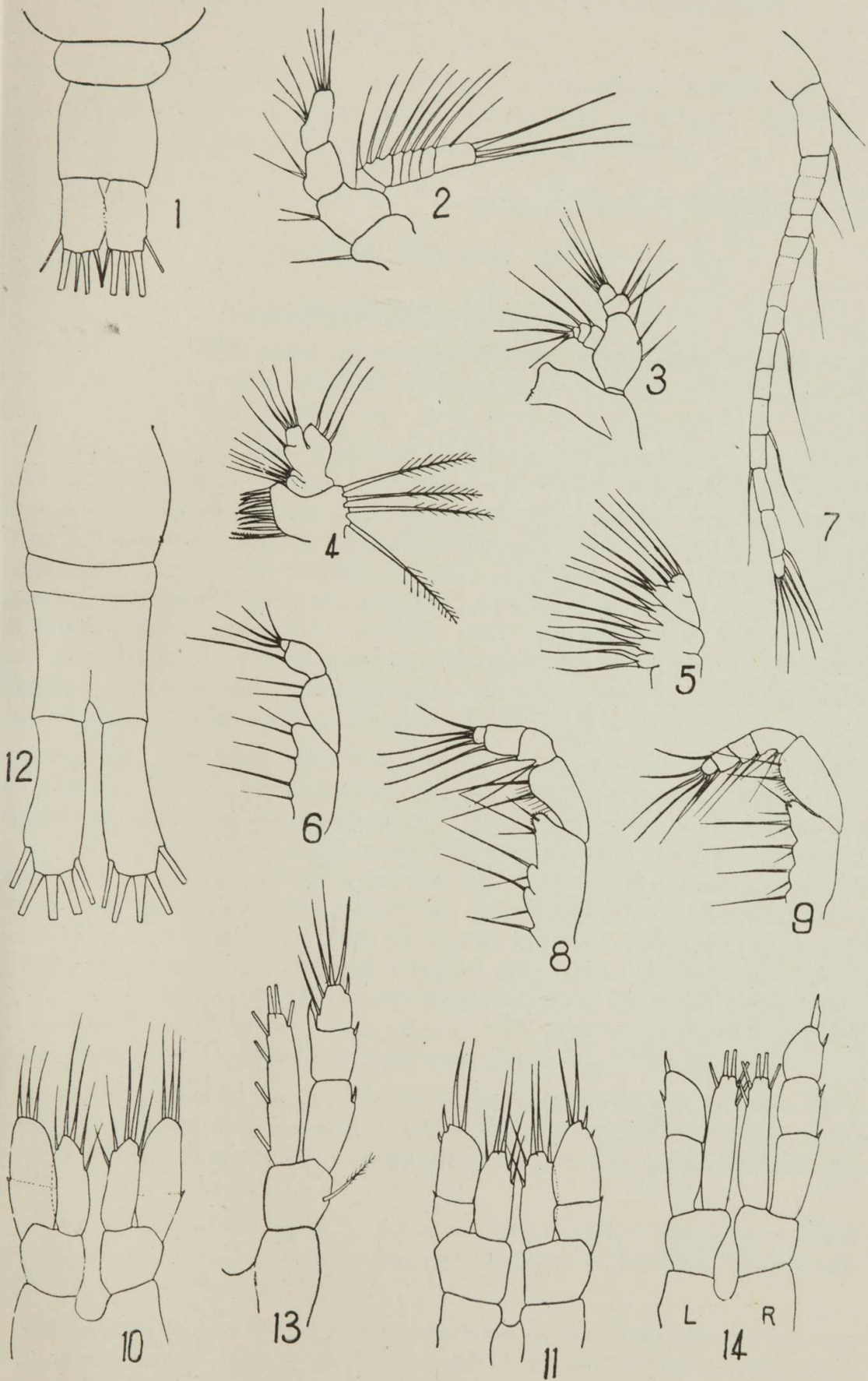


PLATE VI.